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13. ABSTRACT (Maximum 200 words) Objective: We present the frequencies of various types of mandibular fractures along with associated mechanisms and injuries. Methods: Retrospective analysis of 5,196 mandible fractures in 4,381 patients extracted from the Total Army Injury and Health Outcomes Database (TAIHOD), a comprehensive database developed by the U.S. Army Research Institute of Environmental Medicine (USARIEM) that links population data to all hospitalizations among active duty Army soldiers. Results: We found the following frequencies for specific mandible fracture locations: angle 35.6%, symphysis 20.1%, subcondylar 14.2%, body 12.7%, condylar process 9.1%, ramus 4.5%, alveolar border 2.7%, and coronoid process 1%. The mechanisms of injury were separated into seven categories. Fighting accounted for 36.2%, automobile accidents for 18.6%, athletics for 13.6%, falls for 9.7%, motorcycle accidents for 3.1%, other land transport accidents for 3% and miscellaneous causes for 15.8%. A few fracture locations appeared to be associated with specific mechanisms. Of 82 alveolar border fractures with known mechanisms, 37% resulted from automobile accidents. Of 1,094 angle fractures with known mechanisms, 48.6% resulted from fighting. Our data show that the vast majority of fractures were isolated to one location. 3,593 (82%) have only one fracture recorded, 764 (17%) have two fractures recorded, 21 (.4%) have three fractures recorded, and 3 (< 0.1%) have four fractures recorded. Associated injuries were rather common and included facial lacerations 1,236 (36.2%), non-mandible facial bone fractures 733 (16.7%), intracranial injury 402 (9.2%), internal injuries 229 (5.2%), fractures of the upper limb 295 (6.7%), fractures of the lower extremity 302 (6.9%), and cervical fractures 26 (0.6%).				
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5196 Mandible Fractures Among 4381 Active Duty Army Soldiers, 1980 to 1998

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Objective: We present the frequencies of various types of mandibular fractures along with associated mechanisms and injuries. **Methods:** Retrospective analysis of 5196 mandible fractures in 4381 patients extracted from the Total Army Injury and Health Outcomes Database (TAIHOD), a comprehensive database developed by the U.S. Army Research Institute of Environmental Medicine (USARIEM) that links population data to all hospitalizations among active duty army soldiers. The database is based on the ICD-9 CM coding system. **Results:** We found the following frequencies for specific mandible fracture locations: angle 35.6%, symphysis 20.1%, subcondylar 14.2%, body 12.7%, condylar process 9.1%, ramus 4.5%, alveolar border 2.7%, and coronoid process 1%. The mechanisms of injury were separated into seven categories. Fighting accounts for 36.2%, automobile accidents for 18.6%, athletics for 13.6%, falls for 9.7%, motorcycle accidents for 3.1%, other land transport accidents for 3%, and miscellaneous causes for 15.8%. A few fracture locations appear to be associated with specific mechanisms. Of 82 alveolar border fractures with known mechanisms, 37% resulted from automobile accidents. Of 1094 angle fractures with known mechanisms, 48.6% resulted from fighting. Our data show that the majority of fractures were isolated to one location. Only one fracture was recorded for 70.6%, 29.2% have two fractures recorded, 0.2% have three or more fractures recorded. Associated injuries were common and include facial lacerations 1236 (28.2%), non-mandible facial bone fractures 733 (16.7%), intracranial injury 403 (9.2%), internal injuries 229 (5.2%), fractures of the upper limb 295 (6.7%), fractures of the lower extremity 302 (6.9%), and cervical fractures 34

(0.8%). **Conclusions:** The mechanism of injury is important in determining the most likely resultant mandible fracture in the case of angle of mandible and alveolar ridge fractures. The clinician should maintain a high level of suspicion for associated injuries that occur more than one fourth of the time and even more frequently in motor vehicle accident victims. Associated intracranial injury is particularly important to rule out. Associated facial fractures, intracranial injury, internal injuries, and extremity injuries are all more common than cervical fractures.

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INTRODUCTION

The mandible has been reported to be the most commonly fractured facial bone in blunt trauma.^{1,2} The two predominant mechanisms for these injuries appear to be assaults and automobile accidents, although rates appear to vary by local population. In studies with a large contribution of patients from rural areas, automobile accidents appear to be the predominant mechanism. Studies that include mostly urban populations report violent assault as the predominant mechanism.^{1,3-7} Thus, demographic factors may be especially important. Reported risk factors for mandibular fractures include race, socioeconomic level, history of drug abuse, and driving while intoxicated.² In this article we look at a specific population of which there are no previously reported studies of mandibular fractures, the active duty army.

While any given population studied may exhibit a preponderance of one injury mechanism or another, it is not clear which mechanisms are associated with any given type of mandibular fracture. By examining a large population, this article analyzes fracture locations with respect to injury mechanism or activity at the time of injury. We draw our data from one of the largest groups of mandible fractures yet reported in the literature. We report data from a multicenter 18-year retrospective analysis of 5196 mandible fractures among 4381 active duty army soldiers from 1980 to 1998.

MATERIALS AND METHODS

Cases were extracted from the Total Army Injury and Health Outcomes Database (TAIHOD).⁸ The TAIHOD is a comprehensive database developed by the U.S. Army Research Institute of Environmental Medicine (USARIEM) that links popula-

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tion data to all hospitalizations among active duty army soldiers. A hospitalization includes any inpatient or outpatient surgical procedure or hospital admission. Patients cared for by the oral surgery service are included. All records are linked, by an encrypted social security number, at the level of the individual soldier. Military hospitals and civilian hospitals admitting army soldiers are included. The data used for this study covers an 18-year period from 1980 to mid-1998.

This article relies on the ICD-9-CM⁹ coding system for recording injury type and the STANAG 2050 system¹⁰ for recording injury cause and activity. Each patient record includes a maximum of eight diagnosis codes (ICD-9-CM) and a single injury cause code (STANAG). The criteria for selection of the cases were based on the presence of an ICD-9-CM code between 802.20 and 802.39 in any of the eight possible diagnosis fields. This allows precise fracture classification (based on ICD codes), analysis of associated injuries (using secondary diagnosis fields), as well as evaluation of activity or cause associated with various fracture types (based on STANAG cause codes).

The ICD-9-CM coding system, seen in Table I, allows classification of eight mandibular fracture types. Fractures may occur at the condylar process, subcondylar region, coronoid process, ramus, angle, symphysis, alveolar border, and body. For the analysis of fracture types by location, we rely on the electronic patient records to specify each individual ICD-9-CM code and do not include the multiple site code (802.29 and 802.39). Unfortunately, not all fractures in our series were classified. There are 2118 that were either unspecified or given the ICD-9-CM code to denote multiple fracture sites. The remaining 3078 fractures were used in calculating the frequencies of fracture location and number of concomitant mandibular fractures.

RESULTS

As demonstrated in Figure 1, men were responsible for 96% of the hospitalizations for mandibular fractures. The average age of the injured population was 22 years old (range, 17–50).

We found the following frequencies for specific fracture locations: angle 35.6%, symphysis 20.1%, subcondylar 14.2%, body 12.7%, condylar process 9.1%, ramus 4.5%, alveolar border 2.7%, and coronoid process 1% (Fig. 2).

The mechanisms of injury were separated into seven categories: automobile accidents, motorcycle accidents, other land transport accidents (including non-traffic accidents, tanks, transport vehicles, and so on), athletics and

sports, falls, fighting, and miscellaneous. In considering mandible fractures overall, fighting accounts for 36.2%, automobile accidents 18.6%, athletics 13.6%, falls 9.7%, motorcycle accidents 3.1%, other land transport accidents 3%, and miscellaneous 15.8% (Table II).

We next looked at each specific fracture location and found the distribution of mechanisms for each. Table II provides a summary of this data. Each row of the table provides the distribution of injury mechanism for the specific fracture location seen on the left. With exception of the alveolar border, fighting is the most common injury mechanism for all fracture locations, accounting for, 35% to 48.5%. Automobile accidents account for the majority of alveolar border fractures at 35.7%. As previously noted, the above numbers are calculated from 3078 fractures which received specific coding for fracture location.

In analyzing the number of simultaneous mandible fractures, we found a single fracture to be the most common. The 3078 fractures mentioned above occurred in 2344 patients. Of these patients, 70.6% have only one fracture recorded, 29.2% have two fractures recorded, and 0.2% have three or more fractures recorded.

The most common associated injuries are facial lacerations. These occurred in 1236 patients (28.2%). This group is followed by facial bone fractures, which included 733 patients (16.7%). The facial fractures can be divided into malar and maxillary fractures: 426 (9.7%); nasal fractures: 133 (3.0%); orbital blowout fractures: 73 (1.7%); and unspecified: 101 (2.3%). Intracranial injuries were seen in 403 patients (9.2%). These included anything from mild concussion to intracranial hemorrhage. Skull fractures account for the next group of associated injuries, occurring in 297 patients (6.8%). The next group of associated injuries is internal injuries to the thorax, abdomen, or pelvis, which occurred in 229 patients (5.2%). Fractures of the upper limb were seen in 295 patients (6.7%). Fractures of the lower extremity occurred in 302 patients (6.9%). Overall, 13.6% of mandibular fractures had concomitant extremity injury. A small amount of cervical fractures occurred (34 patients; 0.8%). All of these associated injuries are summarized in Table III.

DISCUSSION

The mechanisms of mandibular fractures previously reported in the literature vary considerably by population. For example, there appears to be fewer mandible fractures caused by violent assault in rural communities as compared with urban centers. In analyzing the data of this study, it is important to consider how the active duty army composition differs from that of the general population. While the median age of 27 for all active duty soldiers is younger than the general population, the average age for soldiers sustaining mandibular fractures was similar to the general population at 22 years.^{1,3,5} In this study, 96% of mandibular fracture cases were male, as compared with other studies reviewed which range from 75% to 81%.^{1,3–7} This is consistent with a predominantly male population in which women account for only 14.8%.¹¹ The army population may also be unique in other important ways. There may be a greater ethnic diversity in the army than in many civilian study populations. As of February 1998,

TABLE I.
ICD-9-CM⁹ Codes for Mandible Fractures.

Mandible Fracture Location	Closed	Open
Unspecified site	802.20	802.30
Condylar process	802.21	802.31
Subcondylar	802.22	802.32
Coronoid process	802.23	802.33
Ramus, unspecified	802.24	802.34
Angle of jaw	802.25	802.35
Symphysis of body	802.26	802.36
Alveolar border of body	802.27	802.37
Body, other and unspecified	802.28	802.38
Multiple sites	802.29	802.39

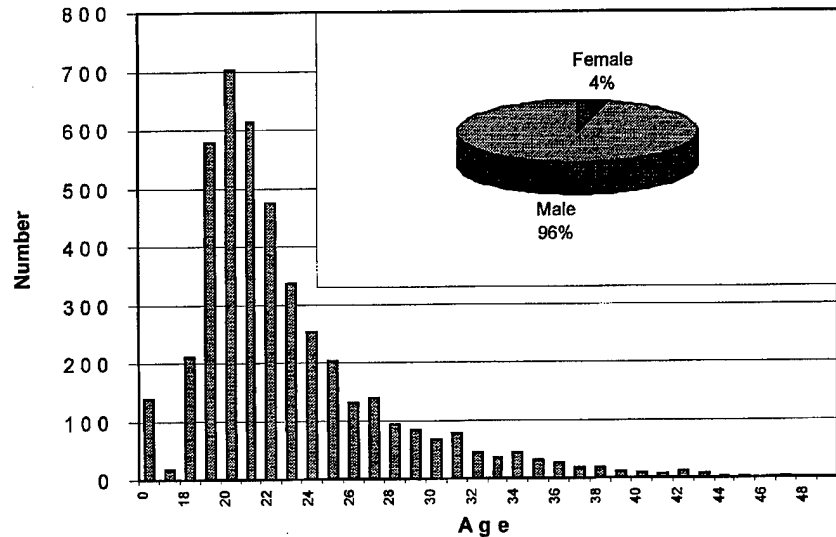


Fig. 1. Distribution of age and sex (n = 4381 patients).

the total active duty force numbered 491,707. Race distribution of all active duty soldiers was 60.5% white, 26.8% black, 6.5% Hispanic, and 6.3% of other ethnic groups. Army soldiers are selected for service and must pass a number of hurdles before they can enlist, including physical mental screening and background checks for criminal convictions or drug use. Illicit drug use is strictly forbidden and screened for rigorously. Driving while intoxicated carries a far greater punishment than for civilians; it will end a promising military career. Helmets and reflective vests are required for all personnel riding motorcycles. The use of seatbelts is mandatory for active duty personnel.

The population described in this study differs from what may be encountered in an urban emergency room where there is a larger percentage of women, homeless people, people who abuse illicit drugs, and people who sustain accidents resulting from driving while intoxicated.

With regard to mechanism of injury, the majority of mandibular fractures in the army population occurred as a result of fighting. Given the demographic composition of

the army, this is probably consistent with other studies. A survey of the literature reveals that the two most common causes of mandible fractures are assault and motor vehicle accidents. Studies in which assault is the primary mechanism include those by Fridrich, Haug, Lim, and Scherer. These papers collected their data from urban populations. Studies in which motor vehicle accidents are the primary cause include those by Olson and Zachariades. In contrast, the source of data for these papers includes greater contribution from surrounding rural communities. The difference between mechanisms in these studies seems to reflect the local demographics of the reporting institutions rather than the nature of mandibular fractures. Although most bases are not in urban centers, fighting as a mechanism predominates in this study. We speculate that might be the result of a young population undergoing combat training. It is important to note that the 18-year period of 1980 to 1998 captures the army population during an interval when large-scale military conflicts were rare. Only Operations Desert Shield/Desert Storm were

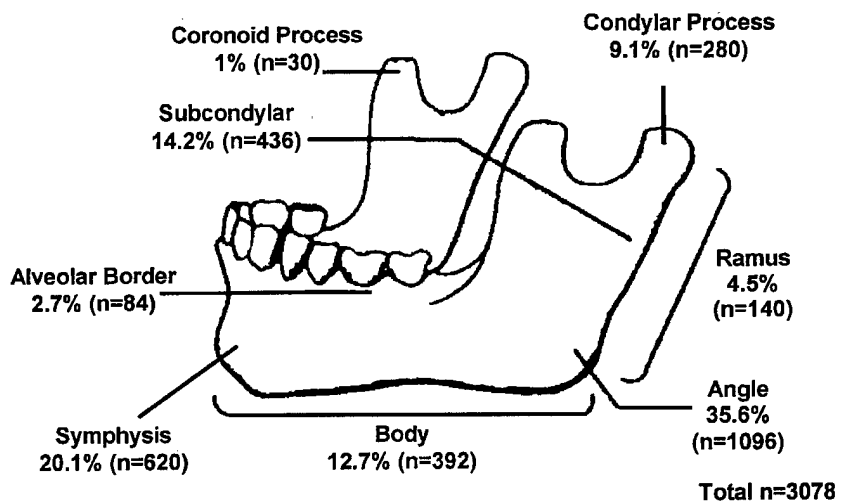


Fig. 2. Distribution of fracture location.

TABLE II.
Fracture Location With Mechanism (n = 5196 fractures).

	Fighting	Automobile	Athletics and Sports	Falls	Motorcycle	Other Land Transport	Miscellaneous
Alveolar border	17.9%	35.7%	10.7%	13.1%	1.2%	7.1%	14.3%
Angle	48.5%	8.1%	20.2%	6.7%	0.8%	0.9%	14.8%
Body	39.8%	14.3%	19.1%	7.4%	2.3%	1.5%	15.6%
Condylar process	35.0%	14.6%	10.4%	19.3%	2.5%	2.9%	15.4%
Coronoid process	40.0%	16.7%	16.7%	3.3%	3.3%	6.7%	13.3%
Ramus	35.0%	17.1%	19.3%	7.1%	3.6%	1.4%	16.4%
Subcondylar	36.5%	14.9%	15.6%	14.0%	1.4%	1.4%	16.3%
Symphysis	40.8%	11.5%	14.2%	11.1%	2.3%	1.8%	18.4%
Combined	36.2%	18.6%	13.6%	9.7%	3.1%	3%	15.8%

important contributors to morbidity during this interval. In fact, only seven of the mandibular fractures in our study occurred as a result of armed conflict. Our study would almost certainly have several different results if this were not the case. The army is, however, constantly engaged in hazardous training and peacekeeping missions. In addition, young males are the group most frequently involved in physical altercations.

While it is apparent that the local population will affect the predominant causes of mandibular fractures, it is not clear if the mechanism of injury will affect the type of fracture sustained. To attempt to answer this question, we looked at each of the seven fracture locations and calculated the frequency of causes for each. As can be seen in Table II, each fracture location shares a similar distribution of injury mechanism. The data collected does not suggest many differences among the mechanisms for each fracture location. There are, however, two sites about which we may find some differences.

Fighting appears to be the major cause of fractures of the angle. While fighting is the most predominant cause for nearly all fracture locations, a significantly greater proportion of angle fractures come from fighting than is seen at other sites. In addition, angle fractures represent the majority of fractures caused by fighting. Of the 1274 classified fractures caused by fighting, angle fractures account for 41.8%. This shows that there is a strong relationship between fighting and angle fractures. Ours is not the only study to suggest this. In all the studies shown in Table IV, the angle is either the first or second most

common location of fracture. All studies, except the one done by Olson, list assault as the most frequent mechanism. The majority of fractures in Olson's series were caused by automobile accidents, thereby skewing the data toward that mechanism. Perhaps the lateral blow caused by a fist accounts for the fractures in the area of the angle. The second most common cause of angle fractures is sporting activities, accounting for 20.2%. Conversely, of 522 classified fractures caused by athletics, the majority involved the angle (42.3%). In our study, 37.9% of the sports-related fractures came from football, 16.3% from basketball, and 16.3% from softball. All of these sports have the potential for lateral blows to the mandible as well. It is interesting that only 8% of angle fractures come from automobile accidents. This agrees with the lateral blow hypothesis, because most automobile accidents will cause an anterior blow. Of note, 24.6% of all angle fractures were open.

While alveolar border fractures account for only 2.7% of our cases, we still have a sample of 82. They are remarkable for being the only type in which fighting is not the predominant mechanism. The majority (37%) is caused by automobile accidents. This was followed by 18% from fighting. It can be seen that alveolar fractures are twice as likely to occur from automobile accidents than fighting in our data. When looking at mechanisms, it can be seen that alveolar fractures account for 7.9% of 381 classified fractures caused by automobile accidents and 1.2% of the 1274 classified fractures caused by fighting. This shows that nearly seven times more alveolar frac-

TABLE III.
Percentage of Mandibular Fractures With Associated Injury.

	Haug	Fridrich	Olson	Boole
Facial laceration	32%	29.9%	29.8%	28.2%
Facial fracture	8.5%	40.4%	25.5%	16.7%
Intracranial injury	18.4%	Not stated	Not stated	9.2%
Skull fracture	2.3%	Not stated	26.2%	6.8%
Thorax, abdomen, pelvis	12%	43.3%	13.5%	5.2%
Extremities	20%	51.7%	18.1%	13.6%
C-spine	3.3%	11%	3.6%	0.8%

TABLE IV.
Distribution of Mandible Fractures in Several Studies.

	Haug	Fridrich	Greene	Olson	Boole
Angle	27.3%	26.7%	35%	24.5%	35.6%
Condylar and subcondylar	21.1%	26%	15%	29.1%	23.3%
Symphysis and parasymphysis	19.5%	23.6%	27%	22%	20.1%
Body	29.5%	11.3%	22%	16%	12.7%
Ramus	2.1%	2.2%	Not stated	1.7%	4.5%
Alveolar border	Not stated	1.1%	Not stated	3.1%	2.7%
Coronoid	0.2%	1.3%	1%	1.3%	1%

tures result from automobile accidents than from fighting. Olson's paper shows a similarly increased number of alveolar border fractures from automobile accidents, 4.5% compared with fighting, 0.7%, or nearly 7:1.⁵ Automobile accidents likely result in anterior loading of the mandible, whereas blows from a fist will generally result in lateral loading. Difference in vectors of force is likely an etiology of this observed difference. Fracture at one location most commonly occurred in our study. Greene reports 58% of mandibular fractures were multiple in 802 patients.² However, all of these fractures were caused by assault, as he did not look at other mechanisms. For this reason, Greene's population is somewhat different from our own. No other study reviewed listed data about multiple sites. We can find no significant association between the mechanism of injury and different numbers of concomitant fractures.

It is important to examine which injuries are associated with mandible fractures to aid in their early recognition. The percentages of related injuries found in ours and other studies may be seen in Table III. The most common associated injuries are facial lacerations in our study and those by Haug, Fridrich, and Olson. This type of injury is not likely to be missed on examination. However, other facial bone fractures could potentially be missed. This group is the second most common associated injury at 733 patients (16.7%). It makes sense that the maxilla is the most frequent of facial bones to be injured when one considers its proximity. The percentage of nasal and orbital blowout fractures is curiously low, considering that the majority of mandible fractures result from fighting. This may be a result of inaccurate coding. One would be remiss to fail to diagnose an intracranial injury considering its prognostic implications. It must be noted that nearly 10% of our patients did indeed suffer an intracranial injury. These include anything from a mild concussion to intracranial hemorrhage. In contrast, we only found 0.8% of our patients to have cervical spine injury. So, while it is always important to consider c-spine injury in patients with mandible fracture, it is even more important to pay attention to mental status in these patients.

Of note, in every study mentioned, motor vehicle accidents are the predominant cause of mandibular fracture in which there is an associated injury.

The ICD-9-CM coding system, on which our data relies, is simultaneously our greatest strength and weakness. Its advantage is it potentially allows for very specific

fracture classification. Unfortunately, the quality of information is reliant on the accuracy of coding clerks retrospectively interpreting physician notes and assigning codes. This potential variation in coding is compounded by our data being pooled from a large number of institutions caring for army soldiers. Fortunately, the large numbers in this study limit the importance of any variation in coding practices.

CONCLUSION

Our data, obtained from the active duty army, is based on similar demographics as previous studies of civilian populations with respect to age, sex, and mechanism of injury. Therefore, our results should be applicable to the civilian community. Young males aged 20 to 29 are the predominant group of people sustaining mandibular fractures. The two main mechanisms that cause mandibular fractures are assault and motor vehicle accidents with the majority of studies, including our own, listing assault as the number one cause. Fighting is closely related to angle fractures, accounting for a greater percentage of them than for other fracture locations. The majority of alveolar ridge fractures come from automobile accidents as compared with other mechanisms. The majority of mandible fractures occur in only one location at a time. Facial lacerations are the most frequently associated injury. As many as 10% of mandible fractures are associated with intracranial injury. Cervical spine trauma was seen in only 0.8%. Whenever there is an associated injury, automobile accidents are the cause in the majority of the cases. Twenty-five percent of all mandible fractures are open.

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